REMARKS

Claims 1-8 remain in this application. Claim 1 has been amended to better define Applicants invention and new claim 8 has been added. Claims 1-7 were rejected as anticipated by Inokuchi. Applicants respectfully traverse this rejection.

There are basic differences between the present invention and Inokuchi. This reference discloses connecting a DIES server with various devices through a network N and reading out primary inspection information from a server into a review-SEM through a work station, in which the review-SEM moves the sample to a position which is specified based on the primary inspection information. (See column 16, lines 59-65, column 19, lines 15-17 and column 18, lines 11-21.) However, such a construction does not include all of the elements of the present invention.

The characteristic feature of the present invention is in an electron microscope to display (a) the position of defects observed by another apparatus (b) a field of view pointed to by a pointing device and (c) a vicinity of the field of view, on a display. According to such display, since the position of the defects can be detected while visually observing a positional relation between the coordinates of the defects obtained by the another apparatus and an actual field of view observed by the SEM, there is no need to use a field of view in which the defects apparently do not exist. Through this procedure, the defects can be detected easily.

In other words, if defects cannot be detected by the SEM at the position of defects detected by another apparatus, it means that the position at which it can be expected to detect the defects is NOT in the vicinity thereof. Thus, there is no need to unnecessarily search. The defects can be detected easily by searching in a field obtained by confirming a relative positional relation between (a) and (c).

In contrast, according to the Office Action, the Examiner contends that there is a description of automatically moving a defect to the center of the microscope image, column 6, lines 45-68. However, referring to Figs. 16, 18, 19, 74, 75 and 76 etc., these simply show how to move the defects that existed from the beginning in the field of view of the SEM to the center of the microscope image. This is different from the present invention in which a defect which did not exist in the field of view of the SEM from the beginning is moved to the center of the microscope image. Thus, the object of the present invention is quite different from Inokuchi.

Furthermore, although Inokuchi shows displaying a wafer map etc., there is no description of displaying both of the following:

(a) the position of the observing field of view of the SEM based on coordinate information of the fault or defects stored in a memory device, and

(b) the observing field of view pointed to by the pointing device.

In this regard, Inokuchi simply shows only moving the observing field of view of the SEM by using a cursor or keyboard.

As explained above, the object of the present invention is to detect the defects easily, when the defects are not displayed at the position in which the defects are expected to be displayed originally based on the coordinate information obtained by another apparatus. This object of the present invention is attained by displaying the (a) the position of the observing field of view of the SEM, based on coordinate information, and (b) the observing field of view pointed by the pointing device. By having both of these displayed, the observer knows the relationship of the two and can more easily search in the vicinity of the location where the defects are expected to be found.

Nothing in Inokuchi teaches or suggests this concept. Therefore the present invention as claimed in claim 1 and the claims dependent thereon is not obvious over Inokuchi.

In view of the above, all claims are now in condition for allowance, prompt notice of which is respectfully solicited.

The specification has been corrected as requested by the Examiner. In view of the large number of corrections, a clean copy of the substitute specification has been enclosed along with a version showing change.

The Examiner is invited to call the undersigned at (202) 220-4200 to discuss any information concerning this application.

Applicants respectfully request a two month Extension of Time to respond to the Office Action of November 4, 2002. The extended period expires April 4, 2003.

The Office is hereby authorized to charge the fee of $410.00 for a Petition for Extension of Time Under 37 C.F.R. § 1.136(a) and any additional fees under 37 C.F.R. § 1.16 or § 1.17 or credit any overpayment to Deposit Account No. 11-0600.

Respectfully submitted,

Date: March 27, 2003

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SUBSTITUTE SPECIFICATION
MARKED VERSION

TITLE OF THE INVENTION

ELECTRON MICROSCOPE

BACKGROUND OF THE INVENTION

~~[0001]~~

[0001] The present invention relates to an electron microscope for observing or detecting a surface or inside of a semiconductor wafer or a mask for exposing a semiconductor pattern for faults and/or foreign objects, particularly to an electron microscope for observing or detecting a surface or inside using coordinates of faults and/or faults which were measured by another wafer/mask inspecting apparatus.

~~[0002]~~

[0002] Faults or objects on a semiconductor wafer or a mask for exposing a semiconductor pattern may give fatal problems to the semiconductor performances and reduce the efficiency of production of semiconductors.

~~[0003]~~

[0003] Therefore, to increase the production efficiency of semiconductors, it is required to remove unwanted objects from wafers and masks and faults from semiconductor patterns or mask patterns on the wafers as much as possible. Therefore, it is thought to be very important to detect and observe wafers and masks for faults and/or objects (hereinafter generically described as faults) in the production of semiconductors and analyze the causes of the faults.

~~[0004]~~

[0004] Recently, semiconductors have become smaller and smaller and their performance may be seriously damaged by even a fault of about 0.1 micron on a wafer. Conventionally an optical fault inspector or an optical object inspector

(hereinafter generically described as an inspector) is used to locate faults on a wafer, move the field of view of the electron microscope to the location where the faults exist according to information on fault coordinates or the like obtained by said inspector, observe and identify the fault.

~~[0005]~~

[0005] However, a wafer/mask area to be observed at a time at a magnification is limited although it is dependent upon the size of a display screen of the electron microscope. Therefore, if fault coordinates measured by another inspector contain errors, the fault cannot be caught in the field of view of the electron microscope.

~~[0006]~~

[0006] Although various techniques have been supported to eliminate coordinate errors between the electron microscope and another inspector, such techniques cannot assure coordinate accuracies high enough to capture all faults in the field of view of the electron microscope.

~~[0007]~~

[0007] To search faults, the operator gradually moves the field of view of the electron microscope using a pointing device (such as a mouse or a trackball) according to fault coordinates measured by another inspector and the location of the field of view of the electron microscope in reference to a wafer map, a die/chip diagram or an optical microscope image which is displayed separately. The conditions of observation of the electron microscope (such as a magnification) is calculated and set from data obtained by another inspector.

~~[0008]~~

[0008] However, at a high magnification, for example, x10,000 of the electron microscope, said conventional techniques do not have any means to show where the observation is made now and it is very difficult to move the field of view of the electron microscope to a position for observation.

~~[0009]~~

[0009] Further, to detect target faults in the field of view of the electron microscope or to set conditions of observation for the field, the conventional technique must calculate observation conditions such as a magnification for each fault from numeric data obtained by another inspector.

~~[0010]~~

[00010] Further, the conventional technique cannot use coordinate errors obtained in search of a fault easily for search of other faults, searching of the conventional technique is not efficient.

~~[0011]~~

[00011] Furthermore, in case both an area which was already observed by an electron microscope and an area which has not been observed are separately displayed on-screen, it sometimes happened that the conventional technique could not change conditions of observation of the electron microscope or involuntarily initialized displays.

SUMMARY OF THE INVENTION

~~[0012]~~

[00012] An object of the present invention is to solve the aforesaid problems and to provide an electron microscope which enables the operator to move and set the field of view onto an area having a fault easily and accurately.

~~[0013]~~

[00013] To attain the aforesaid object, the present invention is characterized by the following.

~~[0014]~~

[00014] In accordance with the present invention, an electron microscope for observing a surface or inside of a semiconductor wafer or a mask for exposing a

semiconductor pattern for faults and/or foreign objects comprises

a function of loading measurement data of coordinates or sizes of faults or objects which were observed by another wafer or mask inspecting apparatus, moving the field of view of the electron microscope to the area where said fault or object exists, and displaying the coordinates of faults or objects which were obtained by another wafer or mask inspecting apparatus, the field of view of the electron microscope and its vicinity,

a function of a pointing device switch which moves the field of view of the electron microscope to a position which is pointed to by a pointer on said display, and

a function of changing the display as said field of view moves.

~~[0015]~~

[00015] The electron microscope in accordance with the present invention can display fault coordinates obtained by another inspectors, the field of view of the electron microscope and its vicinity, enlarge or shrink the views by operation of a pointing device or according to the movement of the field of view of the electron microscope or move the vicinity at a constant magnification.

~~[0016]~~

[00016] Further, the operator can move the field of view of the electron microscope by pointing to a desired position on the view with a pointing device.

~~[0017]~~

[00017] This enables the operator to know the position or area which is now observed and to move the field of view of the electron microscope easily to an area near the fault coordinates obtained by another inspector.

~~[0018]~~

[00018] Further, fault sizes are displayed on a screen showing the field of view and the display is changed according to the condition of observation of the electron microscope.

~~[0019]~~

[00019] Therefore, the operator can set conditions of fault observation for the field of view of the electron microscope and detect faults in the field of view according to the fault shapes.

~~[0020]~~

[00020] Furthermore, the electron microscope in accordance with the present invention has a function of displaying fault coordinates and distances of the field of view obtained by another inspector, storing the values, and moving the field of view of the electron microscope relatively by the stored distances.

~~[0021]~~

[00021] This function enables a coordinate error in a fault searching to be used for search of another faults and increase the efficiency of searching.

~~[0022]~~

[00022] Both an area which was already observed by an electron microscope and an area which has not been observed are separately displayed on-screen. These views are changed when the conditions of observation of the electron microscope are changed.

~~[0023]~~

[00023] This enables efficient observation of non-observed areas only independently of conditions of observation of the electron microscope and prevents incomplete observation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a schematic view of a system configuration of a scanning electron microscope which is an embodiment of the present invention.

FIG.2 shows a schematic screen layout of the CRT of the workstation or a personal computer to operate the electron microscope of the present invention, including a field-of-view and a vicinity field.

FIG.3 is an illustration explaining a procedure of enlarging or shrinking the field-of-view and its vicinity of the electron microscope of Embodiment 1.

FIG.4 is a flowchart explaining a procedure of enlarging or shrinking the field-of-view and its vicinity of the electron microscope of Embodiment 1.

FIG.5 is an illustration explaining a procedure of enlarging or shrinking the field-of-view and its vicinity of the electron microscope of Embodiment 2.

FIG.6 is a flowchart explaining a procedure of enlarging or shrinking the field-of-view and its vicinity of the electron microscope of Embodiment 2.

FIG.7 is an illustration explaining a procedure of moving the vicinity field according to the movement of the field-of-view in Embodiment 3.

FIG.8 is a flowchart explaining a procedure of moving the vicinity field according to the movement of the field-of-view in Embodiment 3.

FIG.9 is a schematic diagram explaining a procedure of displaying a fault in the field-of-view of Embodiment 4.

FIG.10 is a schematic diagram explaining a movement of the field-of-view ~~field~~ of the electron microscope of Embodiment 5 and a procedure of displaying a distance between the fault coordinates and the center of the field-of-view.

FIG.11 shows an example of separately displaying areas, which are already observed and areas, which have not been observed in Embodiment 6.

DETAILED DESCRIPTION OF THE ~~PREFERRED EMBODIMENTS~~ INVENTION

~~[0024]~~

[00024] One embodiment of the present invention will be explained below with reference to the accompanying drawings. This embodiment uses a three-button mouse as a pointing device. However, it is not intended as a definition of the limits of the present invention.

~~[0025]~~

[00025] FIG.1 is a schematic view of a system configuration of a scanning electron microscope 1, which is an embodiment of the present invention. Electron beams 2 emitted from an electron gun 2 are condensed by an electron lens 3, scanned and deflected 2-dimensionally by a defector 4, and applied to a specimen 5. When hit by the electron beams, the specimen generates secondary particles such as reflected electrons and secondary electrons according to the shape and material of the specimen. These secondary electrons are detected by a detector 6 and amplified by an amplifier 7.

~~[0026]~~

[00026] A signal output from the amplifier 7 is A/D-converted into a digital image data by an image processor 8 and the digital image data is ~~realtime-~~displayed in real time on the CRT of a workstation or a personal computer 9.

~~[0027]~~

[00027] The workstation or the personal computer 9 is connected to a computer for controlling the electron microscope by a transmission medium (not visible in FIG.1). The operator can submit various commands from the workstation or the personal computer 9 to the controlling computer 10 to move the specimen stage 11 of the electron microscope. As the specimen stage 11 moves, the field of view of a specimen 5 also moves on the CRT of the workstation or the personal computer 9.

~~[0028]~~

[00028] A semiconductor wafer or mask 12 is sent to an optical inspecting apparatus 13 (another wafer/mask inspector) and undergoes a fault inspection to detect faults 14 on the wafer or mask 12. The optical inspecting apparatus 13 collects information about coordinates and sizes of faults 14 on the wafer or mask and outputs the result.

~~[0029]~~

[00029] The wafer or mask 12 inspected by the optical inspecting apparatus 13 is set on the specimen 11 of said electron microscope. At the same time, the result of

inspection made by the optical inspecting apparatus 13 is sent in an information medium (transmission, floppy disk, MO, etc.) to the workstation or the personal computer 9 of the electron microscope.

~~[0030]~~

[00030] The workstation or the personal computer 9 corrects the coordinates of the wafer or mask on the specimen stage of the electron microscope according to the coordinate information in said inspection result. Next, the specimen stage 11 of the electron microscope, that is the field of view, is moved to the coordinates on which a fault 14 exists and the obtained microscope image is displayed on the CRT of the workstation or the personal computer 9.

~~[0031]~~

[00031] FIG.2 shows a schematic screen layout of the CRT of the workstation or a personal computer 9. This screen shows detailed information, the field of view, and its vicinity.

~~[0032]~~

[00032] The CRT screen 21 which is the display screen of the present invention shows an electron microscope image and the graphical user interface (GUI) for the operator. The CRT screen comprises a field for an electron microscope image 22, a field for a pointer 23 as a pointing device, a field for a field-of-view 26 of the electron microscope, a field for a vicinity 24 of the field of view of the electron microscope, a field for the center coordinates 25, and a field for a list 27 of inspection results of faults obtained by the optical inspecting apparatus 13. The field-of-view 26 of the electron microscope shows an observation area including the electron microscope image 22.

~~[0033]~~

[00033] Data obtained by the optical inspecting apparatus 13 contains the coordinates and size of each fault detected by the optical inspecting apparatus. The

field for a vicinity 24 of the field of view of the electron microscope shows fault positions and sizes according to these kinds of information. These kinds of information obtained by the optical inspecting apparatus 13 are stored in the storage means of the workstation or the personal computer 9.

~~[0034]~~

[00034] The pointing device to operate the GUI on the CRT screen 21 is a three-button mouse 28 having a left button 29, a center button 30, and a right button 31.

~~[0035]~~

[00035] The operator ~~takes~~ follows a procedure explained below to search for a fault. The operator first selects a fault in the fault list 27, clicks the left button 29 of the mouse on it. The field of view of the electron microscope moves to the coordinates of the selected fault.

~~[0036]~~

[00036] The view of the area ~~in~~ to which the field of view positions is displayed in the electron microscope image field 22. At the same time, the coordinates of the fault selected from the list is placed in the center 25 of the vicinity field 24 and the field of view 26 is displayed in the vicinity field to indicate the position of the field of view relative to the center coordinates.

~~[0037]~~

[00037] In some cases, a selected fault is not found in the new field of view at the coordinates of the fault selected from the list, which is obtained by the optical inspecting apparatus. This is because of unreliable fault coordinates obtained by the optical inspecting apparatus, errors of the specimen stage of the electron microscope, or a difference between the magnification of the optical microscope and the magnification of the electron microscope. In this case, the operator moves the field of view 26 of the electron microscope to the vicinity of the fault, that is, towards the center of coordinates 25, which indicate the coordinates of the fault obtained by the

optical inspecting apparatus.

~~[0038]~~

[00038] With this, the operator can recognize the position or area of the current field of view of the electron microscope relative to the fault coordinates obtained by the optical inspecting apparatus at a glance and easily move the field of view of the electron microscope at a high magnification around the fault coordinates obtained by the optical inspecting apparatus where a fault must exist.

~~[0039]~~

[Embodiment 1]

[00039] Below will be explained an embodiment of the present invention which enlarges or shrinks the field of view of the electron microscope and its vicinity.

~~[0040]~~

[00040] FIG.3 is an illustration for explaining a procedure of enlarging or shrinking the field of view of the electron microscope and its vicinity and FIG.4 shows its flowchart.

~~[0041]~~

[00041] The operator moves the field of view of the electron microscope to the fault coordinates obtained by the optical inspecting apparatus. The field for the field-of-view 26 of the electron microscope, the vicinity field 24, the center of coordinates 25, and the actual size 41 of the vicinity field are displayed on-screen.

~~[0042]~~

[00042] By clicking the center button 30 or the right button 31 of the mouse anywhere in the vicinity field 24, the operator gets a step value 42 to change the actual size 41 of the vicinity field (S11). The operator can enter any step value.

~~[0043]~~

[00043] When the operator clicks the center button 30 (S12), the workstation or personal computer subtracts a step value from the current actual size 41 of the vicinity

field and gets a new vicinity field size (S13).

~~[0044]~~

[00044] Next, the workstation or personal computer calculates the display size of the field of view 26 of the electron microscope relative to the new vicinity field (S16) and displays the enlarged field-of-view ~~field~~ and the enlarged vicinity field as shown in FIG.3 (b) (S17).

~~[0045]~~

[00045] When the operator clicks the right button 31 (S14), the workstation or personal computer adds a step value to the current actual size 41 of the vicinity field and gets a new vicinity field size (S15).

[00046] Next, the workstation or personal computer calculates the display size of the ~~field of view~~ field-of-view 26 of the electron microscope relative to the new vicinity field (S16) and displays the shrunk field-of-view ~~field~~ and the shrunk vicinity field as shown in FIG.3 (c) (S17).

~~[0046]~~

[00047] This function enables the operator to specify the rate of enlargement or shrinkage of the vicinity field of the fault coordinates obtained by another inspecting apparatus by numeric values. Accordingly, in case the deviation of fault coordinates can be estimated according to the types of optical inspecting apparatus or in case the deviation of fault coordinates can be estimated for each unit on a wafer, the operator can change sizes of the vicinity field and search a target fault efficiently.

~~[0047]~~

[00048] Further, the operator can recognize the size of the field-of-view ~~field~~ relative to the vicinity field at a glance and estimate the number of fields-of-view ~~fields~~ required to observe before searching the result. This can easily tell the quantity of works required for searching.

~~[0048]~~

[Embodiment 2]

[00049] Below will be explained a second embodiment of the present invention which enlarges or shrinks the ~~field of view~~ field-of-view of the electron microscope and its vicinity. FIG.5 is an illustration for explaining a procedure of enlarging or shrinking the ~~field of view~~ field-of-view of the electron microscope and its vicinity and FIG.6 shows its flowchart.

~~[0049]~~

[00050] The operator moves the ~~field of view~~ field-of-view of the electron microscope to the fault coordinates obtained by the optical inspecting apparatus. Referring to FIG.5 (a), ~~the field for~~ the field-of-view 26 of the electron microscope, the vicinity field 24, the center of coordinates 25, and the actual size 41 of the vicinity field are displayed on-screen.

~~[0050]~~

[00051] In some cases, a selected fault is not found in the new ~~field of view~~ field-of-view at the coordinates of the fault selected from the list, which is obtained by the optical inspecting apparatus 13. This is because of unreliable fault coordinates obtained by the optical inspecting apparatus, errors of the specimen stage of the electron microscope, or a difference between the magnification of the optical microscope and the magnification of the electron microscope.

~~[0051]~~

[00052] In such a case, to observe a target fault as an electron microscope image, the electron microscope of this embodiment enlarges or shrinks the vicinity field 24 as the field-of-view ~~field~~ 26 moves without changing the field-of-view ~~field~~ 26 in the vicinity field 24.

~~[0052]~~

[00053] The operator moves the ~~field of view~~ field-of-view by operating the pointing device and gets a step value to enlarge or shrink the vicinity field (S21). The

operator can enter any step value.

~~[0053]~~

[00054] Next, the workstation or personal computer checks whether the new ~~field of view~~ field-of-view (after movement) is in the vicinity field. As shown in FIG.5 (b), if the field of view 26 is not in the vicinity field, the entered step value 42 is added to the actual size of the current vicinity field size (S23). As shown in FIG.5 (c), the result is used as the actual size ~~42~~ 41 of a new vicinity field (S24). With this, the new shrunk ~~field of view~~ field-of-view ~~field~~ and the new shrunk vicinity field are displayed (S25).

~~[0054]~~

[00055] When the ~~field of view~~ field-of-view is in the vicinity field, the entered step value 42 is subtracted from the actual size 41 of the current vicinity field (S26).

~~[0055]~~

[00056] Next, the workstation or personal computer checks whether the new ~~field of view~~ field-of-view (after movement) is in the vicinity field (S27). If the ~~field of view~~ field-of-view 26 is in the vicinity field as shown in FIG.5 (d), the new enlarged field-of-view ~~field~~ and the new enlarged vicinity field are displayed (S25) with the result of calculation as the actual size 41 of a new vicinity field (S24) as shown in FIG.5 (e).

~~[0056]~~

[00057] In the other cases, the actual size 41 of the vicinity field is not changed and the field-of-view ~~field~~ and the vicinity field will be neither enlarged nor shrunk.

~~[0057]~~

[00058] Each time the operator moves the ~~field of view~~ field-of-view to detect a fault in the ~~field of view~~ field-of-view, the above steps are repeated.

~~[0058]~~

[00059] With this, the field around the fault coordinates is enlarged or shrunk with

the field-of-view ~~field~~ displayed on-screen even when the field of view of the electron microscope is moved to anywhere. Therefore, even when a deviation from the fault coordinate cannot be estimated in advance, the operator can recognize the positional relationship between the ~~field of view~~ field-of-view of the electron microscope and the fault coordinates obtained by another inspecting apparatus just by moving the field of view and can search for faults easily.

~~[0059]~~

[Embodiment 3]

[00060] Below will be explained a third embodiment of the present invention which moves the vicinity field without changing the magnitude of the ~~field of view~~ field-of-view of the electron microscope and the magnitude of the vicinity field. FIG.7 is an illustration for explaining a procedure of moving the vicinity field according to the movement of the ~~field of view~~ field-of-view and FIG.8 shows its flowchart.

~~[0060]~~

[00061] The operator moves the ~~field of view~~ field-of-view of the electron microscope to the fault coordinates obtained by the optical inspecting apparatus. Referring to FIG.7 (a), the field for the field-of-view 26 of the electron microscope, the vicinity field 24, the center of coordinates 25, and the actual size 41 of the vicinity field are displayed on-screen.

~~[0061]~~

[00062] Similarly ~~in~~ to the above embodiments, a selected fault is not found in the new ~~field of view~~ field-of-view at the coordinates of the fault obtained by the optical inspecting apparatus and the deviation cannot be estimated.

~~[0062]~~

[00063] To get an electron microscope image of a target fault in such a case, this embodiment moves the center coordinates 25 in the vicinity field 24 as the ~~field of view~~ field-of-view 26 of the electron microscope moves while keeping the ~~field of~~

~~view~~ field-of-view displayed in the vicinity field 24.

~~[0063]~~

[00064] After the operator moves the ~~field of view~~ field-of-view by operating the pointing device, the workstation or personal computer checks whether the new ~~field of view~~ field-of-view (after the movement) is in the vicinity field (S31). If the ~~field of view~~ field-of-view 26 is not in the vicinity field as shown in FIG.7 (b), the current center coordinates is moved by the actual size 41 of the vicinity field along the movement of the ~~field of view~~ field-of-view as shown in FIG.7 (c) (S32).

~~[0064]~~

[00065] Next, the workstation or personal computer calculates the position of the ~~field of view~~ field-of-view relative to the center coordinates 25 (S33) and checks whether the center coordinates 25 are equal to the fault coordinates obtained by another inspecting apparatus (S34). If the center coordinates are not equal to the fault coordinates, the workstation or personal computer deletes the center coordinates 25 as shown in FIG.7 (d) (S36), displays an arrow 45 oriented to the fault coordinates obtained by the optical inspecting apparatus (S36), and updates the display of the ~~field of view~~ field-of-view 26 (S37).

~~[0065]~~

[00066] If the ~~field of view~~ field-of-view moves out of the vicinity field as shown in FIG.7 (e), the center coordinates 25 is moved by the actual size 41 of the vicinity field as shown in FIG.7 (f) (S32).

~~[0066]~~

[00067] When the new center coordinates 25 (after this movement) match with the fault coordinates obtained by another optical inspecting apparatus, the workstation or personal computer displays the center coordinates 25 as shown in FIG.7 (g) (S38), deletes the arrow 45 which is oriented to the fault coordinates obtained by the optical inspecting apparatus (S39), and updates the display of the ~~field of view~~ field-of-view

26 (S37).

~~[0067]~~

[00068] Each time the operator moves the field of view to detect a fault in the ~~field of view~~ field-of-view, the above steps are repeated.

~~[0068]~~

[00069] With this, the center coordinates are moved by the actual size of the vicinity field without changing the display size of the ~~field of view~~ field-of-view of the electron microscope while the ~~field of view~~ field-of-view is moved anywhere. Further this embodiment indicates a direction in which the fault coordinates obtained by the optical microscope exist. This enables the operator to search faults in each field of an accessible size without ~~a~~ fail.

~~[0069]~~

[Embodiment 4]

[00070] FIG.9 shows an example of displaying a fault in the field-of-view ~~field~~ in accordance with the present invention.

~~[0070]~~

[00071] The workstation or the personal computer calculates the size of a fault in the field-of-view ~~field~~ 26 within the vicinity field 24 from X and Y coordinates of a fault obtained by an optical inspecting apparatus and displays the shape 51 (e.g. an ellipse) of the fault in the field-of-view ~~field~~ 26. The fault can have any shape (e.g. a rectangle).

~~[0071]~~

[00072] If information about fault shapes and compositions are available from the optical inspecting apparatus 13, it is also possible to simulate so that the composition information can be recognized.

~~[0072]~~

[00073] When the magnification of the electron microscope image is reduced, the

actual size 41 of the vicinity field is increased in inverse proportion to the magnification and the shape 51 of the fault is reduced with the display ratio of the field-of-view ~~field~~ 26 to the vicinity field 24 unchanged.

~~[0073]~~

[00074] When the magnification of the electron microscope image is increased, the actual size 41 of the vicinity field is decreased in inverse proportion to the magnification and the shape 51 of the fault is increased with the display ratio of the field-of-view ~~field~~ 26 to the vicinity field 24 unchanged.

~~[0074]~~

[00075] With this, the operator can get the relative size of a fault in the field-of-view ~~field~~ at a selected magnification of the electron microscope. Therefore, even when a fault is not actually in the field of view, the operator can set a magnification of the electron microscope fit for searching or observation.

~~[0075]~~

[00076] As the shape of a fault is displayed in the field-of-view ~~field~~ of the electron microscope, the operator can easily recognize a target fault when the fault is hard to be distinguished from a pattern or a plurality of faults exist in the field-of-view ~~field~~.

~~[0076]~~

[Embodiment 5]

[00077] FIG.10 shows an example of moving the ~~field of view~~ field-of-view of the electron microscope and displaying a distance between the center of the ~~field of view~~ field-of-view and the fault coordinates.

~~[0077]~~

[00078] The operator moves the field-of-view ~~field~~ of the electron microscope toward the fault coordinates obtained by the optical inspecting apparatus 13.

[00079] The ~~field for the~~ field-of-view 26 of the electron microscope, the vicinity field 24, the center of coordinates 25, and the distance 61 between the center of the

~~field of view~~ field-of-view and the fault coordinates are displayed on-screen.

~~[0078]~~

[00080] In this status, the center coordinates 25 of the field-of-view ~~field~~ matches with the center coordinates 25 of the vicinity field 24. Therefore, the distance between the center of the ~~field of view~~ field-of-view and the fault coordinates is X=0 and Y=0.

~~[0079]~~

[00081] When the operator moves the pointer 23 (of the pointing device) to a position in the vicinity field 24 to which the operator wants to move the ~~field of view~~ field-of-view of the electron microscope and clicks the left button 29 of the mouse, the ~~field of view~~ field-of-view of the electron microscope moves to the selected position. The workstation or the personal computer calculates the distance between the center coordinates 25 of the vicinity field 24 and the center coordinates 62 of the field-of-view ~~field~~ and displays the result in the "Distance between the region of interest and the coordinates of the fault" field 61.

~~[0080]~~

[00082] When the operator clicks the SAVE button 63, the values set in the "Distance between the region of interest and the coordinates of the fault" field 61 are saved. Next, the operator moves the field of view to another set of fault coordinates and clicks the MOVE button 64. The ~~field of view~~ field-of-view of the electron microscope is relatively moved by a distance which was saved latest.

~~[0081]~~

[00083] As explained above, the operator can easily move the ~~field of view~~ field-of-view of the electron microscope to any place near the fault coordinates. Therefore, this embodiment is very effective to move the ~~field of view~~ field-of-view of the electron microscope directly and easily to any place near the fault coordinates in case a deviation of a fault is estimated.

~~[0082]~~

[00084] With this, when a fault is detected in the ~~field of view~~ field-of-view, the operator can get the distance between the fault coordinates obtained by the optical inspecting apparatus 13 and the actually-observed fault coordinates easily from the content in the "Distance between the region of interest and the coordinates of the fault" field 61. This is very effective when the fault coordinates obtained by the optical inspecting apparatus 13 are not reliable or affected by a stage error. This embodiment can correct such overall coordinate errors between the optical inspecting apparatus 13 and the electron microscope in accordance with the present invention.

~~[0083]~~

[00085] Further, if it is assumed that the other fault has almost the same error, the operator can search the fault efficiently by moving the ~~field of view~~ field-of-view of the electron microscope to the same deviated position by simple button operations.

~~[0084]~~

[Embodiment 6]

[00086] FIG.11 shows an example of separately displaying areas which are already observed and areas which have not been observed yet in accordance with the present invention.

~~[0085]~~

[00087] The field-of-view ~~field~~ 26 moves in the vicinity field 24 as the field of view of the electron microscope moves. In this case, the areas 71, which were already observed are displayed in different colors. This is also true when the ~~field of view~~ field-of-view of the electron microscope is rotated.

~~[0086]~~

[00088] Further, when the vicinity field including the ~~field of view~~ field-of-view of the electron microscope is enlarged or shrunk, the areas 71 which were already observed are enlarged or shrunk according to the size of the vicinity field.

~~[0087]~~

[00089] This prevents re-observation of the already-observed areas or skipping of observation of areas which have not been observed as the areas which were already observed are clearly distinguished from areas which have not been observed even when the ~~field of view~~ field-of-view of the electron microscope is moved or rotated or the vicinity field including the field-of-view ~~field~~ is enlarged or shrunk.

~~[0088]~~

[00090] The present invention can provide an electron microscope for reviewing faults, which are detected by an optical inspecting apparatus, wherein said electron microscope can position its field of view easily and accurately on a target fault regardless of positional errors between different kinds of microscopes.

~~BRIEF DESCRIPTION OF THE DRAWINGS~~

~~FIG.1 is a schematic view of a system configuration of a scanning electron microscope which is an embodiment of the present invention.~~

~~FIG.2 shows a schematic screen layout of the CRT of the workstation or a personal computer to operate the electron microscope of the present invention, including a field-of-view field and a vicinity field.~~

~~FIG.3 is an illustration explaining a procedure of enlarging or shrinking the field of view and its vicinity of the electron microscope of Embodiment 1.~~

~~FIG.4 is a flowchart explaining a procedure of enlarging or shrinking the field of view and its vicinity of the electron microscope of Embodiment 1.~~

~~FIG.5 is an illustration explaining a procedure of enlarging or shrinking the field of view and its vicinity of the electron microscope of Embodiment 2.~~

~~FIG.6 is a flowchart explaining a procedure of enlarging or shrinking the field of view and its vicinity of the electron microscope of Embodiment 2.~~

~~FIG.7 is an illustration explaining a procedure of moving the vicinity field according to the movement of the field-of-view field in Embodiment 3.~~

~~FIG.8 is a flowchart explaining a procedure of moving the vicinity field according to the movement of the field-of-view field in Embodiment 3.~~

~~FIG.9 is a schematic diagram explaining a procedure of displaying a fault in the field-of-view field of Embodiment 4.~~

~~FIG.10 is a schematic diagram explaining a movement of the field-of-view field of the electron microscope of Embodiment 5 and a procedure of displaying a distance between the fault coordinates and the center of the field-of-view field.~~

~~FIG.11 shows an example of separately displaying areas which are already observed and areas which have not been observed in Embodiment 6.~~

ABSTRACT OF THE DISCLOSURE

In order to provide an electron microscope which enables the operator to position the ~~field of view~~ field-of-view easily and accurately on a target fault, the electron microscope for observing a surface or inside of a semiconductor wafer or a mask for exposing a semiconductor pattern for faults and/or foreign objects, is provided comprising a function of loading measurement data of coordinates or sizes of faults or objects which were observed by another wafer or mask inspecting apparatus, moving the field of view of the electron microscope to the area where said fault or object exists, and displaying the coordinates of faults or objects which were obtained by another wafer or mask inspecting apparatus, the ~~field of view~~ field-of-view of the electron microscope and its vicinity, a function of a pointing device switch which moves the ~~field of view~~ field-of-view of the electron microscope to a position which is pointed to by a pointer on said display, and a function of changing the display as said ~~field of view~~ field-of-view moves.

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